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A BREAKTHROUGH IN SOLAR CELL TECHNOLOGY-DYE SENSITIZED SOLAR CELLS

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ABSTRACT

The dye sensitized solar cell DSSCs are currently the most efficient third-generation solar technology available. This makes DSSCs attractive as a replacement for existing technologies in "low density" applications like rooftop solar collectors, where the mechanical robustness and light weight of the glass-less collector is a major advantage. They may not be as attractive for large-scale deployments where higher-cost higher-efficiency cells are more viable, but even small increases in the DSSC conversion efficiency might make them suitable for some of these roles as well.

INTRODUCTION:

The dye sensitized solar cell DSSCs comprises of many important components which include the electrolyte, sensitizer, a light source, etc. Among all, the dye sensitizer is the particular focus area of this particular paper. Metal complex dyes are mostly used as a dye sensitizer. A lot of research has been done using the platinum group metals like ruthenium, rhodium, palladium, rhenium, osmium, etc. While other metal complexes have shown promising efficiency but ruthenium has been the most efficient of all. The polypyridyl complexes of ruthenium have shown the best results in terms of solar efficiency which is as high as 11%. Natural dyes such as fruit extracts like mulberry and cabbage-palm fruit have also been worked upon as an alternative to the conventional ruthenium and other metal dyes. But their performance has not shown appreciable results comparatively. Photochemical stability, which is the other important characteristic apart from solar efficiency, is also not achieved much in these dyes.

Although, the first dye sensitized solar cell (DSSC) was first made in 1991, its commercialization has been a gradual process and till date very scarce production has taken place. With overcoming the shortcomings of the DSSC, it will prove to be an efficient alternative to the commercial silicon based solar cells.

METALS COMPLEX SENSITIZERS:

Metal complex sensitizers have two ligands specifically, ancillary and anchoring. Anchoring ligands are required for the complex adsorption on the semiconductor surface whereas, ancillary are important for tuning of the overall properties of the complex. Photovoltaic performances can be analysed in terms of conversion yield and long term stability. Fulfilling both the criterion in the best possible way have been the polypyridyl complexes of Ruthenium and Osmium. The general structure which is preferred and has proven good for sensitizers is ML2(X)2, where M can be Ru or Os and L is 2,2'-bipyridyl-4,4' –dicarboxylic acid and X presents a halide, cyanide, thiocyanate, acetyl acetonate, thiacarbamate or water substituent group. [1] Among all the Polypyridyl complexes of Ruthenium dyes are the most efficient ones. They can be categorised under carboxylate polypyridyl ruthenium dyes, phosponate ruthenium dyes and polynuclear bipyridyl ruthenium dyes. [2] The panchromatic sensitizers have low molar extinction coefficient in near IR region which turns out to be a drawback for the improvement in the performance of the DSSC. As a consequence, there have been research carried out on near IR dyes as sensitizer for DSSC which include ruthenium complexes containing biquinoline or 1,8-naphthyridyl moieties, cyclometallated ruthenium complexes, osmium polypyridyl complexes, and phthalocyanine and perylene dyes. Osmium sensitizers were found to 50% less efficient than Ru complexes, but they have greater photochemical stability compared to Black dye. Rhenium (I) complexes based benzathiazole derivatives have been reported to exhibit solar energy efficiency of around 1.43-1.76%.

NATURAL DYES:

The second type of dye sensitizers used is the organic or the natural dyes. Coumarin derivatives, merocyanine derivatives and polyene dyes have been designed successfully as organic-dye photosensitizers in DSSCs, and high solar energy to electricity conversion efficiencies of up to 8% under AM 1.5 irradiation have been attained. The lower performance of DSSCs based on organic dyes compared to those based on Ru complexes is probably due to the lower open-circuit voltage (Voc) that is generated in the DSSCs based on organic dyes, rather than the performance of the short-circuit photocurrent density, which is almost the same. [3] Novel iminocoumarin dyes having carboxyl and hydroxyl anchoring groups have been investigated.The IPCE value for iminocoumarin dye sensitized solar cell was 21.38%. The overall low efficiency of the dyes is ascribed to the lack of light harvesting ability at longer wavelength region. [4] Fruit dyes like mulberry and others have also been tested for DSSC. [5]

CONCLUSION:

The sustainability crisis has encouraged the growth in research in the different sections of DSSC including sensitizers, thin films and other semiconductors, redox couples. Different aspects of dye sensitized solar cell have been focused and investigations have been thus carried on. Many sensitizers including inorganic and organic dyes have been used. Of all the sensitizers reported the Ruthenium complexes have been the most preferred because of their high conversion efficiency which now have reached to 11%. Dye sensitized solar cells will commercially overcome the conventional Si based solar cells in the coming future.

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